Reprinted from Soil and Crop Science Society of Florida
Proceedings, Volume 37, November 30-December 1, 1977

Correlation of Productive Capacity and Estimated Yields for Selected Florida Soils[1]

D. DE LA ROSA AND V. W. CARLISLE[2]

ABSTRACT

A soil evaluation system was used to determine the relative suitability of several Florida soils for production of corn, watermelon, citrus, and soybean. Yield values obtained were related through linear regression analysis to those estimated in Soil Survey Reports by the U. S. Department of Agriculture. Highly significant correlations were obtained between predicted yield values and the reference data, although the coefficients of variation were relatively large in some cases. Considerable differences were found in regression coefficients; however, in hyperthermic soils, these coefficients were close to 1.00. Based on the regression and correlation coefficients, the coefficient of variation, and the number of soils considered, it was concluded that this soil evaluation system or similar systems may be used to evaluate relative soil suitability for specific crop production.

Additional Index Words: Soil survey interpretation, Relative soil suitability, Linear regression and correlation.

Soil characteristics and properties provided by soil surveys are interpreted to give a general suitability of the soils for agricultural uses. Soil survey interpretations also provided information on woodland, wildlife, and engineering purposes suitability. However, information is seldom provided on relative soil suitability for specific crops.

Estimated yields as published in soil survey reports are based mostly on past production records, not on soil properties. Because of the natural and socioeconomic factors which have influences in the complex production process, only evaluations of soil productive capacity based on soil properties can supply satisfactory results.

A proposed system of soil evaluation (4) for specific cultivated crops has been used successfully in Spain (3). It measures the relative soil suitability for cultivated crops based on soil production capacity. In this investigation, an attempt was made to apply this system to several Florida soils.

MATERIALS AND METHODS

CHARACTERISTICS OF THE SYSTEM

Crops used in the original system which was developed in Spain were: wheat, corn, watermelon, potato, soybean, cotton, sunflower, sugarbeet, alfalfa, peach, citrus, and olive. This selection was based on the most promising agricultural uses, not only in the physical sense but also in the socio-economic aspects, in a benchmark area within the Mediterranean Region.

Soil factors considered as diagnostic criteria in the study were analyzed according to the general scheme proposed by Beek and Bennema (1). The following soil factors were included: effective depth (p), texture (t), drainage (d), carbonate content (c), salinity (s), sodium saturation (a), and profile development (g).

According to the generalization level set up for each soil factor, five classes of relative suitability were defined. Classes may be further subdivided into subclasses by using letters to correspond with the major limiting factors. For establishing predicted yields by the soil evaluation system the maximum estimated yields under excellent management were considered as guidelines for establishing the optimum yields. Classes correspond to the following optimum yields:

- Class I – 100% optimum yield (for no limitations)
- Class II – 95-90-85% optimum yield (for one, two, or three limitations)
- Class III – 80-75-70% optimum yield (for one, two, or three limitations)
- Class IV – 65-60-55% optimum yield (for one, two, or three limitations)
- Class V – 50-45-40% optimum yield (for one, two, or three limitations).

---

[1]Florida Agricultural Experiment Stations Journal Series Number 961. This work was supported in part by the Program of Cultural Cooperation between the United States of America and Spain, administered by the Fulbright Commission.

[2]Soil Scientist with Centro de Edafologia del Cuarto de Sevilla, Spain, and PCCUSAS Fellow, University of Florida; and Professor of Soil Science, University of Florida, respectively.

FLORIDA APPLICATIONS

Astatula, Felda, and Myakka series from the hyperthermic region and Lakeland, Plummer, and Tifton series from the thermic region were selected for applying this system to Florida soils. Crops used were corn, watermelon, citrus, and soybean.

Information on crop yields for these soils was obtained from Soil Survey Reports of 10 Florida counties (7, 8, 9, 10, 11, 12, 13, 14, 15, 16). These estimated yields were based on estimations made by farmers, soil scientists, and others who had knowledge of yields in the counties and on information taken from research data, under excellent management, which included: adequate amounts of fertilizer, lime, or manure; a well planned cropping system and proper use of crop residues; water control measures; improved plant varieties and certified seeds; control of insects and plant diseases; control of runoff and erosion; and protection for crops against cold weather damage (16). Yields reported in published soil surveys as pounds/acre, bushels/acre, crates/acre, boxes/acre, and number/acre were all converted to metric tons/hectare.

Properties and classification of soil series were taken from the USDA Soil Survey Reports (7, 8, 9, 10, 11, 12, 13, 14, 15, 16). Analytical data were obtained from a research report which contained characterization data for selected Florida soils (2).

Predicted yields, based on soil properties as discussed by de la Rosa et al. (4), were subjected to linear regression and correlation analyses as dependent variables with estimated yields from published Soil Surveys serving as the independent variables (5).

RESULTS AND DISCUSSION

The six soil series investigated and their taxonomic classification (6) are shown in Table 1. A total of 102 observations on four crops was used in this study. Table 2 shows the estimated average crop yields on each soil series. Corn yields in the hyperthermic region are for sweet corn and in the thermic region for field corn. Recent soybean production has increased dramatically in the hyperthermic region but past production was insufficient to be included in this study. Citrus does not commonly occur in the thermic region. Great differences in yields of watermelon are evident between the hyperthermic and thermic soils.

Suitability subclasses and expected yields by the soil evaluation system are presented in Table 3. Frequency corresponds to the number of soils grouped in each suitability subclass. Differences between subclass for watermelon in the hyperthermic and thermic regions are not great. This is contrary to considerable differences between estimated yields of this crop in the two regions due to factors other than pedologic characteristics. It is interesting to note that soil series with the same suitability unit may belong to different subgroups in Soil Taxonomy (6) and some series which are under the same subgroup belong to different suitability units (Table 1). For statistical analyses the soil series were grouped separately according to their occurrence in the thermic or hyperthermic temperature zone.

CORN

Regression analysis of the 37 pairs of values showed

TABLE 1.—TAXONOMIC CLASSIFICATION OF SOILS INVESTIGATED.

Series	Family	Subgroup	Order
	Hyperthermic		
Astatula	Hyperthermic, uncoated	Typic Quartzipsamment	Entisol
Felda	Loamy, siliceous, hyperthermic	Arenic Ochraqualf	Alfisol
Myakka	Sandy, siliceous, hyperthermic	Aeric Haplaquod	Spodosol
	Thermic		
Lakeland	Thermic, coated	Typic Quartzipsamment	Entisol
Plummer	Loamy, siliceous, thermic	Grossarenic Paleaquult	Ultisol
Tifton	Fine-loamy, siliceous, thermic	Plinthic Paleudult	Ultisol

TABLE 2.—ESTIMATED AVERAGE YIELDS UNDER EXCELLENT MANAGEMENT.

Soil	Corn[1]			Watermelon			Citrus			Soybean		
Series	Obs.	Range	Mean	Obs.	Range	Mean	Obs.	Range	Mean	Obs.	Range	Mean
	metric tons/ha											
	Hyperthermic soils											
Astatula	•			5	24.64-35.84	31.36	8	15.68-20.16	17.92	•		
Felda	5	6.16-8.96	7.39	4	34.64-26.88	24.88	6	17.92-19.04	18.64	•		
Myakka	8	5.04-8.96	7.39	8	6.72-22.40	9.24	5	9.75-15.68	13.26	•		
	Thermic soils											
Lakeland	8	2.24-2.80	2.66	5	8.96-11.20	10.75	•			5	1.34-1.68	1.41
Plummer	8	1.88-4.49	2.65	6	6.72- 6.72	6.72	•			3	2.02-2.02	2.02
Tifton	8	3.14-5.02	4.08	5	7.62-10.64	8.72	•			5	1.68-2.35	1.95

[1]Sweet corn and field corn yields for hyperthermic and thermic soils, respectively.
•Not recorded in the Soil Survey Reports.

TABLE 3.—SUITABILITY SUBCLASSES AND PREDICTED YIELDS OBTAINED BY THE SOIL EVALUATION SYSTEM.

Corn			Watermelon			Citrus			Soybean		
Frequency	Subclass	Yield	Frequency	Subclass	Yield	Frequency	Subclass	Yield	Frequency	Subclass	Yield
					metric tons/ha						
					Hyperthermic soils						
1	IIp	9.04	1	IIp	37.24	2	IItd	19.13			
1	IIIp	7.62	2	IIt	37.24	3	IItdc	18.06			
3	IIId	7.62	1	IIpd	35.28	2	IIIt	17.00			
2	IIItd	7.14	1	IItd	35.28	1	IIId	17.00			
3	IIIptd	6.66	2	IIptd	33.32	2	IIIpd	15.94			
3	IVd	6.19	1	IItdc	33.32	3	IIItd	15.94			
			1	IIId	31.36	2	IIIptd	14.88			
			4	IIItd	29.40	1	IVp	13.81			
			4	IVd	25.48	3	IVd	13.81			
					Thermic soils						
3	IIptd	8.09	2	IIt	37.24				1	IIpg	2.42
5	IIIp	7.62	1	IIpg	35.28				2	IIptg	2.29
6	IIIt	7.62	1	IItd	35.28				2	IIIp	2.15
1	IIId	7.62	1	IIptg	33.32				1	IIIpd	2.02
2	IIIpt	7.14	1	IItdc	33.32				1	IIItc	2.02
2	IIIpd	7.14	3	IIIp	31.36				1	IIIptd	1.88
3	IIIptd	6.66	1	IIId	31.36				1	IVd	1.75
2	IVtd	5.71	1	IIIpd	29.40				4	IVtd	1.61
			1	IIItd	29.40						
			2	IIIptd	27.44						
			2	IVd	25.48						

Optimum yields considered: corn, 9.52; watermelon, 39.20; citrus, 21.25; soybean, 2.69.

that predicted yields calculated by the soil evaluation system were significantly correlated with estimated yields. In thermic soils, the value of intercept was moderately high (Table 4) because optimum yields used to calculate predicted yields were the same for both regions (Table 3).

Regressions between predicted yield and estimated yield for corn are shown in Figs. 1 and 2. Predicted yields and estimated yields for corn in hyperthermic soils had the best correlation of all crops used in this investigation. In thermic soils, there was a considerable scattering of yield data. This was reflected by the low correlation coefficient and a high coefficient of variation, indicating that the probability of error in applying this soil evaluation system would be relatively high. Most different pairs of yield values were in suitability subclasses limited by natural drainage.

WATERMELON

Predicted yields obtained by the soil evaluation system were highly correlated with those estimated from published Soil Surveys for the 33 soils investigated. The regression coefficient was very high in thermic soils. As in the case of corn, optimum yield was considered the same for both regions.

In hyperthermic soils, although the regression coefficient was close to unity, the coefficient of correlation was moderately low (Table 4). This moderate deviation from the regression line (Fig. 3) was accentuated for values corresponding to soils with only one limitation. In thermic soils, there was a high correlation (Fig. 4) between predicted yields and estimated yields of watermelon.

TABLE 4.—LINEAR REGRESSION OF PREDICTED YIELDS BY THE SOIL EVALUATION SYSTEM ON ESTIMATED YIELDS.

Soil	Obs.	Intercept (a)	Slope (b)	C.V. (%)	R^2	r
			Corn			
Hyperthermic	13	1.45	0.90	16.95	0.92	0.96**
Thermic	24	4.47	0.86	44.10	0.53	0.73**
			Watermelon			
Hyperthermic	17	2.49	1.06	33.02	0.56	0.75**
Thermic	16	13.00	2.08	13.12	0.72	0.85**
			Citrus			
Hyperthermic	19	0.45	0.91	37.82	0.56	0.75**
			Soybean			
Thermic	13	—0.63	1.41	34.76	0.38	0.62*

*, **Statistically significant at 0.05 and 0.01 levels, respectively.

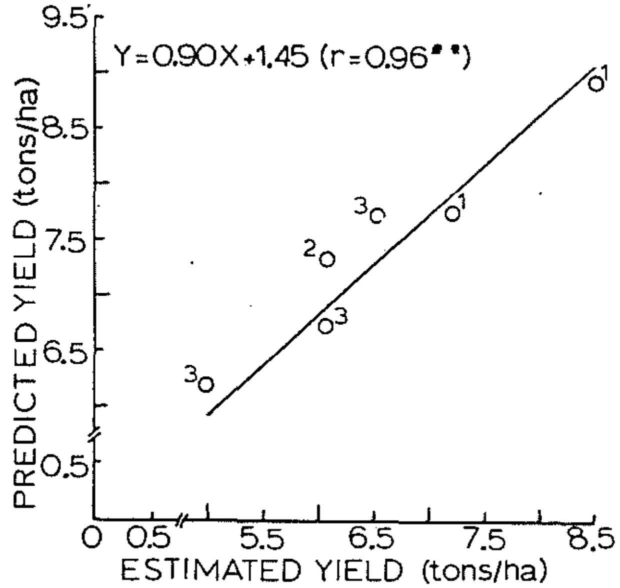

Fig. 1.—Predicted yield versus estimated yield for corn in hyperthermic soils (metric tons).

CITRUS

Results of the regression analysis for 19 pairs of yield values shown in Table 4 denote a significant correlation between predicted and estimated yield. The regression coefficient was slightly less than 1.00. In most cases, the soil evaluation system predicted approximately the same yields as obtained by estimation.

The experimental points (Fig. 5) deviated moderately from the regression line, particularly for low yield values. As in the case of corn, most different pairs of yield values were also in suitability subclasses limited by drainage. The high coefficient of variation (Table 4) indicated that the probability of error in using this system for predicting citrus yields would be moderately high.

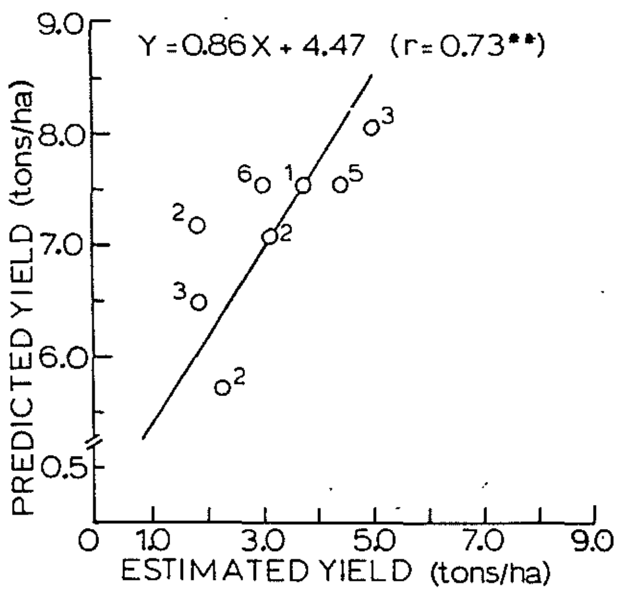

Fig. 2.—Predicted yield versus estimated yield for corn in thermic soils (metric tons).

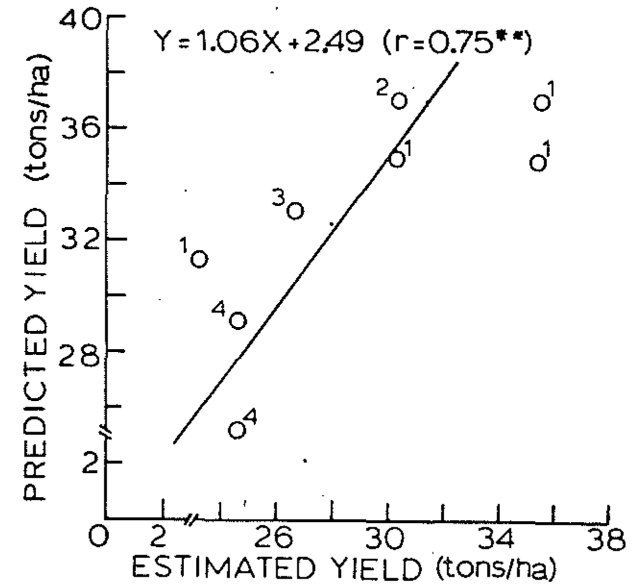

Fig. 3.—Predicted yield versus estimated yield for watermelon in hyperthermic soils (metric tons).

SOYBEAN

Regression analysis for the 13 pairs of yield values for soybean show predicted yields to be slightly correlated with estimated yields. The regression coefficient was moderately high (Table 4).

The correlation coefficient for soybean was the lowest among the 4 crops studied. Considerable scatter of experimental points was noted (Fig. 6). As in the previously indicated cases, the drainage subclasses presented the greatest deviation from the estimated yield values.

CONCLUDING REMARKS

From the results of this investigation, it was concluded that predicted yields calculated by the soil

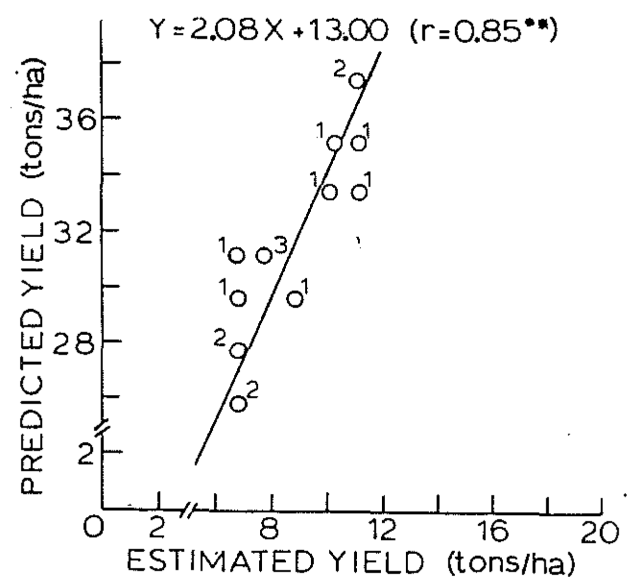

Fig. 4.—Predicted yield versus estimated yield for watermelon in thermic soils (metric tons).

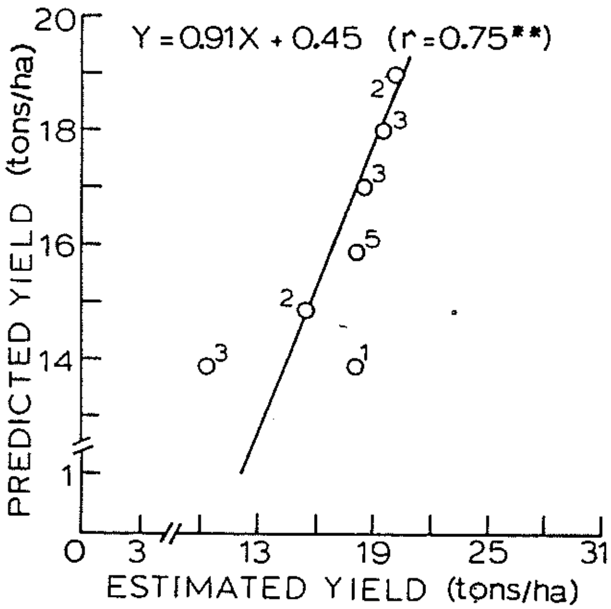

Fig. 5.—Predicted yield versus estimated yield for citrus in hyperthermic soils (metric tons).

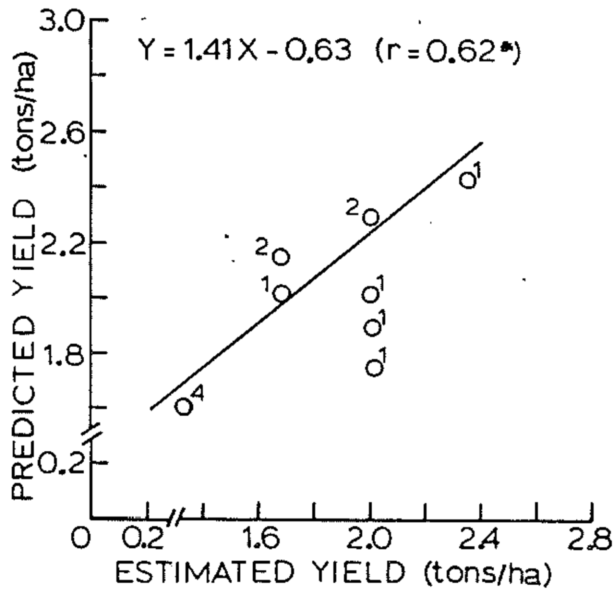

Fig. 6.—Predicted yield versus estimated yield for soybean in thermic soils (metric tons).

evaluation system were significantly related to estimated yields. Application of this system to other soils and under other environmental conditions could allow the calculation of corrective factors which would result in a closer relation to actual yields. Corrective factors are especially needed to evaluate soil drainage as a diagnostic criterion. Results of this investigation as well as the previous report (3) suggest that application of similar soil evaluation systems could be used to indicate the relative soil suitability for most cultivated crops.

LITERATURE CITED

1. Beek, K. J., and Bennema, J. 1972. Land evaluation for agricultural land use planning, an ecological methodology. Afd. Bodemkunde and Geologie. Wageningen, The Netherlands.
2. Calhoun, F. G., Carlisle, V. W., Caldwell, R. E., Zelazny, L. W., Hammond, L. C., and Breland, H. L. 1974. Characterization data for selected Florida soils. Univ. of Florida. Soil Sci. Dept. Rep. No. 74-1. Gainesville, Fla.
3. Centro de Edafologia y Biologia Aplicada del Cuarto. 1976. Soil survey of the Viar and Valle Interior irrigation areas, Sevilla. (In Spanish). Re. Rep. Sevilla, Spain.
4. De la Rosa, D., Cardona, F., and Paneque, G. 1976. Soil evaluation for several agricultural uses. An system developed for mediterranean regions. (In Spanish). An. Edaf. y Agrob. (In Press).
5. Snedecor, G. W. 1957. Statistical methods applied to experiments in agriculture and biology. Iowa St. Co. Press, Ames, Iowa.
6. Soil Survey Staff. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conservation Service, USDA Handbook No 436 U. S. Gov't Printing Office, Washington, D. C.
7. U. S. Department of Agriculture. 1959. Soil survey of Sarasota County, Florida. U. S. Gov't Printing Office, Washington, D. C.
8. U. S. Department of Agriculture. 1960. Soil survey of Escambia County, Florida. U. S. Gov't Printing Office, Washington, D. C.
9. U. S. Department of Agriculture. 1960. Soil survey of Orange County, Florida. U.S. Gov't Printing Office, Washington, D. C.
10. U. S. Department of Agriculture. 1965. Soil survey of Suwannee County, Florida. U. S. Gov't Printing Office, Washington, D. C.
11. U. S. Department of Agriculture. 1965. Soil survey of Washington County, Florida. U. S. Gov't Printing Office, Washington, D. C.
12. U. S. Department of Agriculture. 1971. Soil survey of Okeechobee County, Florida. U. S. Gov't Printing Office, Washington, D. C.
13. U. S. Department of Agriculture. 1972. Soil survey of Pinellas County, Florida. U. S. Gov't Printing Office, Washington, D. C.
14. U. S. Department of Agriculture. 1974. Soil survey of Brevard County, Florida. U. S. Gov't Printing Office, Washington, D. C.
15. U. S. Department of Agriculture. 1974. Soil survey of Holmes County, Florida. U. S. Gov't Printing Office, Washington, D. C.
16. U. S. Department of Agriculture. 1975. Soil survey of Lake County, Florida. U. S. Gov't Printing Office, Washington, D. C.